DOCUMENT RESUME

ED 444 542 IR 020 198

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TITLE Technology Integration and Teaching Expertise.
PUB DATE 2000-00-00
NOTE 7p.; In: Society for Information Technology & Teacher Education International Conference: Proceedings of SITE 2000 (11th, San Diego, California, February 8-12, 2000). Volumes 1-3; see IR 020 112.
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Case Studies; *Computer Uses in Education; Correlation; *Educational Technology; Elementary Education; Faculty Development; Higher Education; Teacher Education; Use Studies
IDENTIFIERS *Expertise; *Technology Integration; Technology Utilization

ABSTRACT

This paper reports on a study that investigated the relationships between technology-use and teaching ability in the practice of elementary teachers. Case study data from exemplary technology integrators, representing various levels of teaching and technology-use ability, led to the formulation of five assertions about ways these teachers taught with technology: (1) the ways technology was used determined the teachers' personal definitions of technology integration; (2) teachers at the lower levels of either technology use or teaching ability altered their planning habits when planning for technology inclusion; (3) teachers taught with and about technology according to their own personal learning strategies; (4) teachers' individual definitions of technology integration directed their management of student computer use; and (5) teachers at the lower levels of either technology-use or teaching ability altered their perspective on assessment when assessing student use of technology. Differences observed among technology-use practices were associated with individual levels of teaching expertise. The paper concludes by proposing a theoretical definition of technology integration, along with specific recommendations for the professional development of both preservice and inservice teachers. (Contains 21 references.) (MES)

Technology Integration and Teaching Expertise

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Abstract: This paper reports on a study that investigated the relationships between technology-use and teaching ability in the practice of elementary teachers. Case study data from exemplary technology integrators, representing various levels of teaching and technology-use ability, led to the formulation of assertions about ways these teachers taught with technology. Differences observed among technology-use practices were associated with individual levels of teaching expertise. The paper concludes by proposing a theoretical definition of technology integration, along with specific recommendations for the professional development of both preservice and inservice teachers.

Introduction

As computer technology reinvents the ways in which we create, find, exchange, and even think about information, school districts are forced to bow to societal pressure to fund technology. Unfortunately, purchases are often approved before implementation plans are in place, a lack of foresight which leaves disparity between teachers who are attempting innovative integration and other users and non-users. The existence of success in isolated pockets prompted this study of how teachers at various levels of technology-use and teaching abilities used technology and how technology-use practice related to general teaching practice.

The history of studying experts in various disciplines has repeatedly identified a series of expert characteristics, (e.g., Glaser, 1990) that include having a highly structured and accessible knowledge base and efficient domain-related routines. It has been shown that pedagogical expertise develops with comparable characteristics. Expert teachers set goals during planning based on their previous knowledge about students and past teaching events (Berliner, 1994). They make a greater number of contingency decisions and consider management and instructional strategies ahead of time (Livingston & Borko, 1989; Westerman, 1991). With an organized store of knowledge, experts employ a set of routines to automate recurring teaching practices (Berliner, 1986; Leinhardt & Greeno, 1986). Past experience supplies insight into student learning needs, confidence to incorporate student input to tailor lessons, and the ability to critically analyze classroom situations to propose solutions (Gonzalez & Carter, 1996; Sabers, Cushing & Berliner, 1991).

Integrating technology into the curriculum is becoming an inseparable part of good teaching. Research on exemplary technology-using teachers has reveals that these individuals spent a good deal of personal time working with computers, had more extensive computer training and teaching experience (Becker, 1994), and had high levels of innovativeness and confidence (Marcinkiewicz, 1993). They were surrounded by colleagues who used computers for meaningful activities, enjoyed school and district level support for technology use (Becker, 1994; Hadley & Sheingold, 1993), and had sufficient staff development opportunity (Office of Technology Assessment, 1995; Ritchie & Wiburg, 1994). Common teaching practices included planning for regular computer use, consistently using technology as a tool in a variety of instructional projects (Evans-Andris, 1995), maintaining higher expectations for student learning, and shifting the focus toward activities that were student-centered (Hadley & Sheingold, 1993) with less whole-group instruction and more independent work (Waxman & Huang, 1996). Finally, these

teachers made conscious decisions to alter established curriculum, allowing student choice in learning activities and promoting varied grouping schemes (Becker, 1994).

The review of literature on expert teaching and exemplary technology use led to a series of research questions: What role do exemplary technology-using teachers perceive for the computer technology in their classrooms for themselves and their students? In what ways do they plan for computer use, and what routines do they establish to facilitate and manage the use of computers in instruction? What strategies do they use to teach with and about computers, and how is learning assessed? And finally, in what ways are the practices of exemplary technology-using teachers comparable to indicators of pedagogical expertise?

Methods

The initial research questions indicated qualitative case study methods. Sixteen elementary teachers from a school district known for a commitment to technology were identified as exemplary technology-users by the Director of Technology, two Teachers on Assignment for technology, school media specialists, and principals, and were observed for a half-day screening interview. It soon became clear that although these teachers had all been recommended as exemplary technology-users, the group was not homogeneous, representing instead a range of combinations of levels of teaching abilities and technology-use abilities. The goal of the study therefore changed from examining only those teachers who were exemplary technology users to comparing individuals at different levels of technology use and teaching abilities. A framework loosely intersecting composite levels of teaching expertise (Berliner, 1994) and stages of teacher technology adoption (Dwyer, et al., 1991) proved an effective way to investigate the variety in the this sampling pool and at the same time gain a richer insight into the relationship between teaching abilities and technology-use abilities. One teacher was finally selected as the best representative of each category. Data from two in-depth interviews, classroom observations, planning "think-alouds", computer-use logs, and technology-related documents were collected during approximately one month per case study classroom over the course of one school year. Through repeated readings of the entire data record, potential themes of teaching and technology-use practice were informally noted and then grouped into larger, related categories.

Interpretation of Findings

This study was designed to understand how teachers at various levels of technology-use and teaching abilities used technology, as well as how technology-use practice related to general teaching practice. Through interpretive analysis, emerging patterns in the data led to the formulation of five assertions that illustrated the ways these teachers taught with technology:

- *Assertion 1*: The ways technology was used determined the teachers' personal definitions of technology integration.
- *Assertion 2*: Teachers at the lower levels of either technology use or teaching ability altered their planning habits when planning for technology inclusion.
- *Assertion 3*: Teachers taught with and about technology according to their own personal learning strategies.
- *Assertion 4*: Teachers' individual definitions of technology integration directed their management of student computer use
- *Assertion 5*: Teachers at the lower levels of either technology-use or teaching ability altered their perspective on assessment when assessing student use of technology.

The comparisons drawn among the strategies these three teachers employed when teaching with technology versus teaching without technology proved most interesting. Evidence presented in this study suggests that these variations in technology use were closely linked to the teachers' respective levels of general teaching expertise.

Exemplary Technology-Use/Adequate Teaching Ability: Steve

Steve's reliance on textbook planning, his teacher-centered approach, and his lack of motivation to modify teaching practices demonstrate his settling into a state of "experienced non-expertise" (Bereiter & Scardamalia, 1993) in which experience is not capitalized on to continue developing knowledge or a fluid level of expertise. In some respects, teaching with technology prompted positive change in Steve's teaching. He gave more thought to lesson planning and taught with enthusiasm. His plans and teaching demonstrated, however, how his technical expertise did not automatically result in quality teacher performance. Many experts in a particular domain are not able to instruct others effectively because they cannot articulate how they do what they do (Berliner, 1994; Bransford, Brown, & Cocking, 1999). Steve's advanced technology skills were developed prior to his teaching skills, and as his teaching had remained somewhat stagnant past his initial pedagogical learning, he had thus far been unable to link his technology expertise to his teaching. Consequently, technology remained a separate activity with regards to planning, management, and assessment, and it furthermore was not connected in a pedagogically sound way to other learning opportunities. Future progression along this line would not likely result in Steve using technology in any concerted or meaningful way to improve the learning of his students.

Exemplary Teaching/Adequate Technology-Use Ability: Jill

Jill had in place established routines and highly organized mental schema for what she considered to be "teaching." She was able to recognize patterns across different subjects and was able to use such knowledge to present fluid, flexible lessons. However, in spite of her interest in learning about technology, she did not recognize technology as being similar to other tools she typically used in her teaching. Expert knowledge has been shown to be contextual and domain specific (Berliner, 1994). Perhaps Jill needed to recognize the place of technology use as related to her general teaching practices before it could become an integral component of her teaching repertoire. By perceiving technology use as a practice distinct from her teaching practices, Jill essentially slipped back into novice teaching habits when teaching with technology. Her plans for technology use remained conscious, deliberate thoughts that were largely separate from other subject matter plans. Others have suggested that expertise is not directly transferable to other situations (Berliner, 1994; Huberman, 1985) and, in fact, must be "reinvented or adapted" (Huberman, 1985, p. 256). The adaptation process for Jill involved seeking ways to utilize technology within the framework of her prior knowledge about teaching.

Exemplary Teaching/Exemplary Technology-Use Ability: Sheila

Because technology was used so pervasively in Sheila's classroom, there were few notable distinctions between the ways she viewed planning, management, and assessment of technology use and her comparable strategies for more traditional learning activities. She made conscious decisions, based on her knowledge of both the content and her students, to use or not use technology tools under certain circumstances. Routines facilitated much of the student computer use, making Sheila available for novel circumstances requiring her attention. On the whole, Sheila's uses of technology were not only the most prolific of the three teachers, but such teaching practices were also the most closely aligned with the content-area curriculum. Using technology so that it is truly a part of what is practiced by an expert teacher with curriculum, rather than as an activity that has its own set of rules, was the meaning of integration to this teacher.

Discussion

Findings from the present study demonstrate how the term *technology integration* can connote very different concepts for different teachers. Perhaps schools are so eager to have teachers begin using

technology that they use the term too freely, mistaking simply having and turning on a computer as *integration*. While it may not be possible to arrive at one indisputable definition of a term so dependent on educational beliefs, technological availability, and even community expectations, the use of research and national standards could help such a concept to be locally defined so that it can be planned for, implemented, assessed, and generally understood by all stakeholders. To aid this understanding, I propose a theoretical definition of technology integration derived from the literature on expertise in teaching. Researchers (Berliner, 1986; Leinhardt & Greeno, 1986; Shulman, 1986; Wilson, Shulman, & Richert, 1987) agree that expert teachers possess both *content knowledge* and *pedagogical knowledge*, the intersection of which is described as *pedagogical-content knowledge*, or knowledge about specific learners and useful ways to represent specific curriculum. The findings of this study suggest adding to the model *technological-knowledge*, which would include not only basic technology competency, but also an understanding of the unique characteristics of technology that would lend themselves to particular aspects of the teaching and learning processes. A teacher who effectively integrates technology would be able to draw on extensive content knowledge and pedagogical knowledge, in combination with technological knowledge. The intersection of the three knowledge areas, or *technological-pedagogical-content knowledge*, would define effective *technology integration*. Figure 1 illustrates the possible relationships between the types of teacher knowledge.

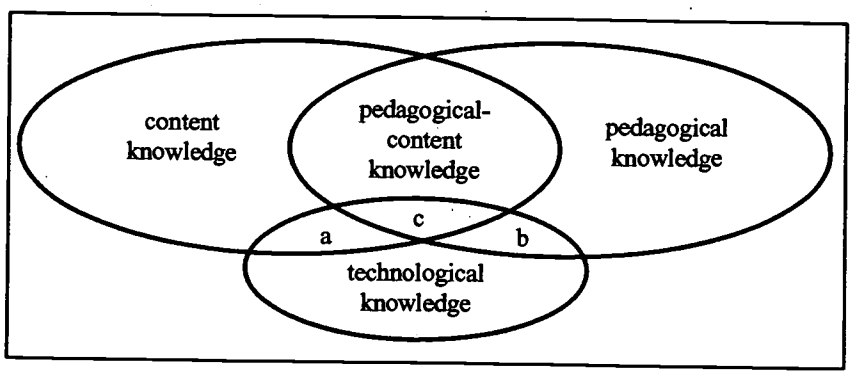

Figure 1: Relationship among content, pedagogical, and technological knowledge. Section (a) represents knowledge of content-related technology resources. Section (b) represents such knowledge as the methods to manage and organize technology use. Section (c) represents the intersection, or *technological-pedagogical-content knowledge*, which is *technology integration*.

Recommendations

This study raises important issues for preservice teacher education and school districts professional development programs.

Recommendations for Preservice Teacher Education

1. If the use of technology is seen as an additional skill that teachers need to acquire once they begin their first teaching assignment, the time necessary to integrate technology into their teaching repertoire will be delayed. Preservice teacher education programs must address this need by designing appropriate program sequences that involve future teachers in using technology for meaningful purposes throughout all subject methods instruction.
2. The relationship between teaching ability and technology-use ability must be made explicit early in a new teacher's education. Rather than have each subject methods component taught separately, college

of education faculty must work together in interdisciplinary teams to coordinate efforts of teaching in general and teaching with technology tools.

3. Attention should be given to the methods that teachers at different levels of teaching ability and technology-use ability employ. Specific communication routes need to be established among preservice students, expert technology-integrating teachers, and teachers who are novices at using technology for instruction.
4. Beginning teachers need valid models of technology integration from the outset, rather than learning to teach and then tackling the challenge of integrating technology later and out of context.

Recommendations for School Districts

1. "One-shot" inservice trainings do not explicitly demonstrate technology connections to other teaching methods that would allow teachers to situate technology use within their rich content and pedagogy knowledge structures. Experienced teachers need time for reflection and collaboration in order to envision technology use in relation to established practices and in multiple contexts.
2. In addition to technology professional development, ongoing efforts must address issues of general teaching improvement. Inservice trainings should not be solely applications-based, such as how to use a particular piece of software, but instead should be problem-based to assist teachers in identifying all of the ways to solve particular teaching problems using a range of tools that include technology.
3. Professional development must view teachers as individual learners, and therefore must be varied and focused on what the learners know, what the content demands, and how assessment and community needs impact learning.
4. If the definition of technology integration is not clear, teachers may believe that any use of a computer is acceptable as technology integration. The devising of a district framework or rubric that outlines the range of ways in which different ability-level teachers might use technology could make professional development efforts more focused and meaningful.
5. Teachers would benefit from release time to witness exemplary technology integration practices from teachers in their own district, with similar student populations and available technology. They might also benefit from videotaped case examples that could be viewed, studied, and repeatedly discussed.

Conclusion

More important than teachers who know how to use computers are teachers who know how to effectively use all of the tools at their disposal for the learning benefit of students. The proposed definition of technology integration suggests that technology in the hands of a merely adequate teacher will lack the experienced and thoughtful motivation necessary to embed it within a context of sound teaching practice. Conversely, technology in the hands of an exemplary teacher will not necessarily result in integrated and meaningful use. Unless a teacher views technology use as an integral part of the learning process, it will remain a peripheral ancillary to his or her teaching. True integration can only be understood as the intersection of multiple types of teacher knowledge and therefore is likely as rare as expertise. Educational leaders would be well served to focus efforts on creating environments that are conducive to continued growth in pedagogy as well as in technology use.

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